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IS 10875 (1983): Glossary of terms and material of construction for rotary dryers and coolers [MED 17: Chemical Engineering Plants and Related Equipment]

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Indian Standard

GLOSSARY OF TERMS AND MATERIAL OF CONSTRUCTION FOR ROTARY DRYERS AND COOLERS

1. Scope — This standard covers definitions and material of construction for rotary dryers and coolers which are commonly used for granular materials.

2. Terminology

2.1 Capacity — Capacity shall imply the quantity of material produced under the stipulated conditions of quality. In the case of rotary dryers it can be expressed as the quantity (kg) of dried material per unit time (h) within stipulated moisture contents at inlet and outlet of dryer, alternatively, the evaporation capacity, which is quantity of moisture (kg) evaporated per unit time (h). In the case of rotary coolers it can be expressed as quantity (kg) of material cooled within stipulated temperature (°C) differential at inlet and outlet of cooler.

2.2 Concurrent Dryer — Concurrent dryer is one in which both wet material to be dried as well as the hot air used for drying enter from the same end and travel in the same direction of the dryer. A basic advantage is that higher inlet temperatures for the hot air can be used.

2.3 Constant Rate Drying — Constant rate drying occurs in the initial stage in drying of wet materials during which period of time the evaporation rate per unit drying surface area remains constant.

2.4 Counter Flow Dryer — Counter flow dryer is one in which the direction of flow of the material to be dried and that of the hot air are opposite. They are also called counter-current flow dryers. A dried product with an extremely low moisture content can be obtained in this set-up.

2.5 Critical Moisture Content — Critical moisture content is the moisture content at a particular time during the drying process when the constant rate drying period changes to the falling rate one. Sometimes it is also referred to as a point differentiating the bound and the unbound moisture content.

2.6 Dry Basis — Dry basis is the representation of the moisture content in the product obtained by dividing the mass of water by the mass of the dry material.

2.7 Dryer Thermal Efficiency — Dryer thermal efficiency is a representation of the percentage of the total heat supplied by the fuel to evaporate a specific amount of water from the product.

2.8 Drying Curve — Drying curve is a graphical representation of the moisture content in the product being dried versus the time during the process of drying. It identifies the constant rate and falling rate regimes as well as the critical moisture content.

2.9 Dust Burden or Loading — Dust burden or loading in the exhaust gases is a representation of the quantity of dust picked up by the exhaust gases and is generally expressed in mg/Nm³.

2.10 Falling Rate Drying — Falling rate drying occurs in the latter stages in the drying of wet materials during which period the change of moisture content goes on decreasing with time elapsed.

2.11 Final Moisture Content — Final moisture content represents the exact moisture content in the final product leaving the dryer or cooler. The oven method is to be followed for determination of moisture contents unless specified otherwise.

2.12 Free Moisture — Free moisture is generally referred to as the water content in a material which is not held by hygroscopic forces. It may include bound and unbound moisture.

2.13 Hold-up — Hold-up is a representation of the total mass of material held in the dryer or cooler at any time of operation. It is expressed either in absolute mass (kg) or as a percentage of the volume of the material to the clear internal volume of the cylindrical shell of the dryer or cooler.

2.14 Moisture Content — Moisture content is a basic representation of the mass of moisture in a product compared to the mass of the product on either dry or wet basis.

2.15 Retention Time — Retention time is the time taken by the feed to travel the length of the dryer or cooler and is the sum of the movement time due to action of the lifters as well as slide along its slope. It is also referred to as the time requirement for which the material has to be retained to complete the process of drying or cooling.

2.16 Wet Basis — Wet basis calculations incorporate the mass of wet material in the denominator. It is obtained by dividing the mass of water by the mass of wet material.

2.17 Specific Power Consumption — Specific power consumption is obtained by dividing the actual electrical energy (kwh) consumed by the complete dryer or cooler installation and its auxiliaries divided by the output (dry basis).

2.18 Specific Heat Consumption or Thermal Requirement — Specific heat consumption or thermal requirement is obtained by dividing the net heat input (J) by the output of dryer (dry basis) in kg per unit time.

3. Nomenclature — The various components of the rotary dryer or cooler shall be designated as in Fig. 1.

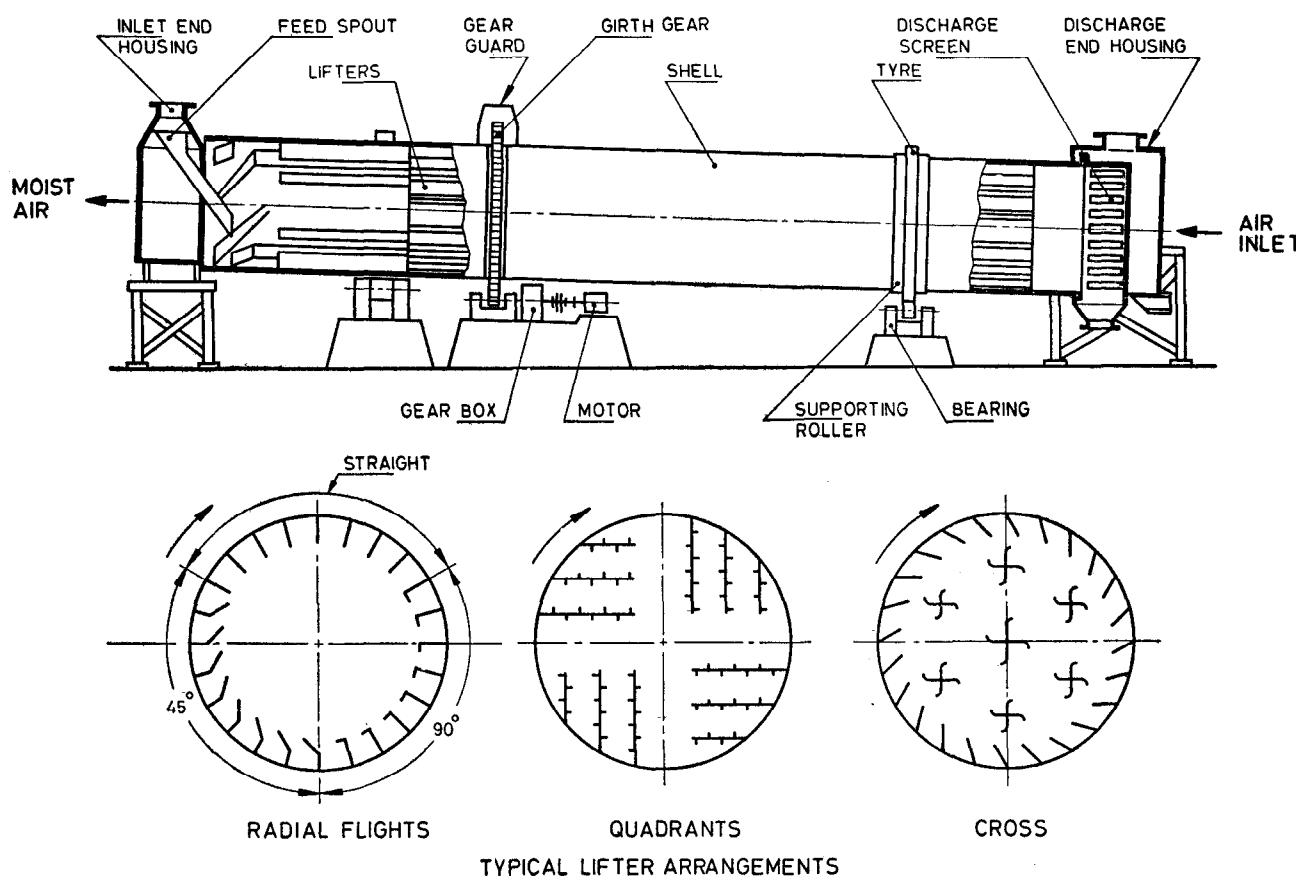


FIG. 1 NOMENCLATURE FOR ROTARY DRYER OR COOLER

4. Classification — The rotary dryers and coolers may be classified as ;

- Batch type, and
- Continuous type.

In the batch type, the charge to be dried or cooled is loaded into the dryer or cooler and after the drying or cooling process it is removed in a batch; whereas in the continuous type, a continuous supply and removal of material is maintained.

4.1 The rotary dryers are further classified as :

- a) Direct heat dryers,
- b) Indirect heat dryers, and
- c) Indirect-direct heat dryers.

4.1.1 Direct heat dryer is one in which the material being dried is brought into direct contact with the drying medium, either in the parallel or counterflow configuration. The heat transfer is predominantly convective.

4.1.2 Indirect heat dryer is one in which the heat to the material being dried is transferred through a metallic wall. The configuration could vary in either shell and tube type or furnace enclosed shell type. Radiation is the dominant mode of heat transfer.

4.1.3 Indirect-direct heat dryer is one employing a combination of the above two principles and applying a double-pass for the hot gases, resulting in a high degree of heat utilization through all the three modes.

4.2 The rotary coolers are further classified as :

- a) Direct coolers, and
- b) Indirect coolers.

4.2.1 Direct cooler is one in which the air used for cooling comes into direct contact, generally in counter flow, with the material being cooled.

4.2.2 Indirect cooler is one in which the cooling medium, air or water, picks up the heat from the material being cooled through a metal wall.

5. Sizes — Sizes of rotary dryers and coolers shall be denoted by the internal nominal diameter and length of the cylindrical shell in metres.

6. Designation — The designation of a rotary dryer or cooler shall include :

- a) Commonly used name,
- b) Classification,
- c) Size designation, and
- d) Number of this standard.

Example :

A rotary sand dryer with an inside diameter of 3'0 m and 18 m long, the hot gases for drying flowing in opposite direction to the feed sand, will be designated as :

Direct Heat Counter-Current Rotary Dryer 3'0×18 IS : 10875-1984

7. Materials — The materials of construction of the rotary dryers and coolers will depend upon the duty requirements of the individual components. Table 1 gives a list of the same in accordance with general practice.

TABLE 1 MATERIALS OF CONSTRUCTION
(Clause 7)

| SI No. | Components | Material/Specification | Remarks |
|--------|----------------------------|--|--|
| i) | Main shell | a) Grade 2 of IS : 2002-1982 Specification for steel plates for pressure vessels for intermediate and high temperature service including boilers (<i>first revision</i>) b) IS : 2062-1980 Specification for structural steel (fusion welding quality) (<i>second revision</i>) c) Stainless steel | |
| ii) | Tyres | a) CS 640 of IS : 2644-1979 Specification for high tensile steel castings (<i>second revision</i>) b) Grade 27-54 of IS : 1030-1982 Specification for carbon steel castings for general engineering purposes (<i>third revision</i>) | For high temperature and corrosive materials |
| iii) | Support rollers | a) CS 640 of IS : 2644-1979 b) Grade 27-54 of IS : 1030-1982 | |
| iv) | Support roller shafts | a) 15 C8 of IS : 1570 (Part 2)-1979 'Schedules for wrought steels: Part 2 carbon steels (unalloyed steels)' (<i>first revision</i>) b) Class 3 of IS : 1878-1978 'Specification for carbon steel, billets, blooms, slabs and bars for forgings' (<i>fourth revision</i>)' | |
| v) | Support roller bearings | a) Antifriction roller bearings b) Journal bearings | |
| vi) | Girth gear | a) CS 65 of IS : 2644-1979 b) Grade 27-54 of IS : 1030-1982 | |
| vii) | Pinion | a) IS 226-1975 'Specification for structural steel (standard quality)' (<i>fifth revision</i>)' | |
| viii) | All other fabricated items | a) IS : 226-1975 b) IS : 2062-1980 | Plate thickness not exceeding 20 mm Plate thickness exceeding 20 mm |
| ix) | Lifters | a) IS : 2062-1980 b) Stainless steel c) Grade 1 of IS : 276-1978 'Specification for austenitic manganese steel castings' (<i>third revision</i>) | For casting |
| x) | Refractories | a) High alumina bricks b) Castables | To suit material temperature profile and abrasive resistance |

EXPLANATORY NOTE

The rotary dryer or cooler consists of a near horizontal cylinder or shell supported by means of tyres or riding rings on plain rollers held in bearings. It is rotated by means of a girth-gear and counter shaft pinion, alternatively a chain and sprocket drive arrangement through a main gearbox. An electric motor is the prime mover in nearly all cases.

The inside of the shell is equipped with flights running throughout the length of the dryer or cooler. These flights lift the material to be dried and shower it across the air stream. The flight configuration, sizes, shapes and geometry vary considerably.

The drying action basically involves the removal of liquid, in most cases water, by converting it into vapour that separates readily from the solid. In the rotary dryer, the drying action is intermediate between that of a particle suspension unit and a static bed.